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AMENDED SPECIFICATION

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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Fixed Increment Advance of Face Conveyors

We, COAL INDUSTRY (PATENTS) LIMITED, a Company organised in accordance with the Laws of Great Britain of Hobart House, Grosvenor Place, London, S.W.1, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to systems for controlling the movement of equipment movable by at least one hydraulic ram. In particular the present invention relates to underground mine roof support systems equipped with horizontal rams for pushing over an advanceable mine face conveyor.

In known mining installations employing a plough in conjunction with an advanceable conveyor, conveyor pushing rams are fixed at intervals along the waste side of the conveyor. These rams are constrained against movement relative to the roof by for example roof support props and the rams are caused to push continuously so that the conveyor is continually forced towards the mineral face.

In practice this continuous pushing by the rams involves difficulties such as:—

1. The ram pushing is determined by the *average* outward reaction of the plough throughout the face, this reaction being the force tending to move the plough away from the face, thereby involving the selection of a pushing pressure which causes the plough to cut too deeply in parts of the face while barely cutting in others. The resulting mine face is not straight thereby causing extreme stress and wear on the installation. To straighten the face short alignment correcting cuts are necessary and these are time consuming and relatively unproductive. Furthermore the continuous pushing often causes the plough to take a progressively deeper cut when cutting areas of soft coal. This is particularly true with sharp blades since these can generate a pulling-in force. When the blades become too deeply embedded in the coal or when the plough moves from an area of soft coal into stronger material the pulling-in force causes the conventionally provided shear pins to fail.

2. The ram pushing pressure forces the plough guide tube or rail (attached to the face side of the armoured face conveyor) hard up against the coal face (this is particularly true in strong coals.) As the guide rail or tube is generally circular or of curved cross-section it rides up over any loose material which has spilled from the face into the plough track, and lifts the conveyor on the face side and tends to cause the plough to cut at some horizon above the same floor as it passes thereby leaving 'crop' coal.

3. In view of the foregoing as the plough passes any given point on the face it has to force the conveyor back to allow passage of the plough body. A conveyor which has thus probably been advanced 12″ is forced back or retracted 9″ thereby enabling a 3″ cut with

the plough. This forced retraction of the conveyor produces very large friction forces between the plough and the conveyor thereby increasing plough chain loads. This also often causes roof supports to be dislodged and hydraulic hoses to be damaged if the former have been set too near to the conveyor.

To overcome some of the above difficulties ramp plate ploughs have been proposed in which the plough blades overhang a ramp attached to the face side of the conveyor by an amount equal to the depth of cut required. It is then supposed that the toe of the ramp plate is pushed right up to the coal face thereby fixing the depth of cut. In practice coal is often trapped between the ramp and the face thereby keeping the toe away from the face and reducing the cut. On other occasions the conveyor pushing force causes the toe of the ramp to penetrate the coal and increase the depth of cut. Both of these circumstances are likely to occur over the length of a coal face and the latter therefore becomes misaligned. Even with ramp plates the high pressures required to cut strong coals causes the conveyor and plough to climb in the seam as mentioned above.

It is an object of the invention to provide a control system, and apparatus for use in such a system, for equipment such as a plough installation which at least reduces the above difficulties.

A system for controlling the advance of a snakable conveyor advanceable by a plurality of double-acting hydraulic rams connected at spaced intervals to the conveyor, according to the invention, comprises, for each ram, control means which is adapted on actuation thereof to cause its associated ram to advance the conveyor by a predetermined increment of distance less than the complete stroke of the ram, and which is adapted to restrain the associated ram against extension and retraction of the ram under the effect of external forces.

Ram apparatus, for use in such a system according to the invention, comprises a double-acting hydraulic ram, a control valve operable to a first position to pass fluid to and simultaneously pass fluid from the ram to causes non-incremental operation of the ram and operable to a second position to prevent exhaust of fluid at least from one side of the ram piston, a variable-volume chamber, and a fluid-pressure-responsive valve operable to pass fluid expelled from the variable volume chamber to said one side of the ram piston so that the ram piston moves through one increment while the control valve is in said second position.

If the invention is applied to a plough and associated snakable conveyor the plough effectively becomes a fixed 'web' machine such as a shearer or trepanning type of machine. With ploughs of the known standard type, the invention enables the conveyor to be advanced to and locked in a position such that there is just sufficient room for the plough body to pass taking a predetermined cut for example 1—4 inches. With ramp plate ploughs, the invention enables the conveyor to be advanced to and locked in a position where the toe of the ramp is a few inches from the face, i.e. a condition which can always be achieved again causing the plough to take a fixed cut. This arrangement ensures that plough faces are kept straight, thereby increasing productivity (all cuts would be full face cuts) and reduces horizon control difficulties. Plough friction forces are considerably reduced by eliminating the push back of the conveyor and by keeping the face straight and therefore extra cutting effort is available to force the machine through the harder parts of the face at a fixed depth of cut.

Reference will now be made to the accompanying drawings in which:—

Figures 1, 2, 3, 4 and 5 each schematically illustrates a different control system according to the invention for advancing a mine face conveyor, and Figure 6 illustrates a detail of the system of Figure 5.

Referring to Figure 1 a plurality of double acting hydraulic rams 1 (only one shown) are attached at spaced intervals to a mine face conveyor 2, arranged along a mine face 2A. Each ram 1 is connected to an abutment 1A such as a roof support or stell prop.

Each ram 1 is controlled by a manually operable control valve 3 connected to the ram pull side by a duct 4 and to the ram push side by a duct 5. The valve 3 is also connected by a duct 6 to a main pressure line 8 and a duct 7 to a main return line 9. Lines 8 and 9 are common to all of the rams 1.

With each ram 1 is associated a fluid store in the form of a fluid dispensing cylinder 10 containing a floating piston 11. The opposite ends of the cylinder 10 are connected through ducts 12 and 13 to fluid lines 14 and 15 common to all of the rams and extending lengthwise of the face. At one end of the face the lines 14 and 15 are connected to a manually operated change-over valve 16 connected through ducts 17 and 18 to the fluid lines 8 and 9 respectively. A non-return valve 19 in the duct 12, allows fluid flow from the fluid line 14 but not in the reverse sense. The duct 12 is connected by a duct 12A to the duct 5. A resiliently loaded pilot operated valve 20 controls fluid flow through the duct 12A. Pilot pressure for the valve 20 is obtained through a duct 13A, from the duct 13.

With the valves as shown in the drawing the circuit of Figure 1 is in its neutral state, in which the pull sides of all of the rams 1 are connected to the main pressure line 8, through the associated ducts 4, the valves 3

and the ducts 6. The rams 1 are constrained against extension under the influence of an external load but cannot exert pulling forces since the necessary displacement of fluid from the push side of the rams is prevented by the closure of the ducts 5 by the valves 3 and the closure of the ducts 12A by the valves 20. The rams 1 are, therefore, constrained from both extension and retraction.

On operating the valve 3 to connect the ducts 4 and 6, and the ducts 5 and 7 respectively the associated ram 1 will pull. If the valve 3 is operated in the opposite sense, to connect ducts 4 and 7 and 5 and 6 respectively the ram will push. By this means the abutment 1A may be advanced or the conveyor 2 may be pushed or pulled to adjust its position and straightness along the face 2A.

In the neutral state, on operation of the valve 16 to connect the lines 8 and 14, the lines 9 and 15, the pressure fluid will flow from the line 8 through the line 14, the valve 19, and the duct 12 to the right hand end of the cylinder 10. At the same time the other end of the cylinder 10 is connected through the duct 13, the line 15, and the duct 18 to the main return line 9. Consequently, fluid is able to enter the cylinder 10 displacing the piston 11 towards the left hand end of the cylinder. Fluid from the left hand side of the piston is displaced through the duct 13, the line 15, and the duct 18 to the return line 9. The system is so arranged that the pressure produced in the ducts 13 and 13A by this operation cannot operate the valve 20. When the piston reaches the left hand end of the cylinder 10, fluid flow will cease. The valve 16 may now be returned to the position shown in the Figure.

On subsequently operating the valve 16 in the opposite sense, to connect the lines 8 and 15 and the lines 9 and 14 in the case of each ram 1, pressure fluid from line 8 will enter the ducts 13. This fluid will not at first flow into the cylinder 10 since displacement of fluid from the opposite cylinder end into the duct 12 is initially prevented by the valves 19 and 20. The pressure in the ducts 13 and 13A will rise until it is high enough to pilot-operate the valve 20 to allow fluid to escape through the duct 12A into the duct 5. Provided that the valve 3 is in its neutral position (as shown) in which it closes the duct 5, the fluid will be forced into the push side of the ram 1. The force on the ram push side will be greater than that on the pull side, by reason of the different effective areas of the two sides of the piston. It is arranged that the difference between these forces will exceed any external load which may oppose ram extension, and will cause the ram to push. Fluid from the pull side will be displaced through the ducts 4 and 6 to the main pressure line 8.

When the piston 11 reaches the right hand end of the cylinder 10 fluid flow will cease and the valve 16 is returned to its neutral state. The above operation will have advanced the ram 1 through a distance less than the total possible stroke of the ram 1. The distance depends upon the ratio of the area of the cylinder of ram 1 to the area of the dispensing cylinder 10 and upon the stroke of the piston 11. The piston stroke may be varied as required, i.e. by stops or the like.

The above described cycle may be repeated until the rams 1 are fully advanced when they may be restored to the fully retracted state by means of the associated valves 3.

In the embodiment shown in Figure 2 the components, fluid lines and ducts numbered from 1 to 11 are similar to corresponding elements of Figure 1 except for the internal connections of the valve 3 when in the neutral position. In Figure 2 the neutral state characteristic of each valve 3 is that the ducts 4, 5, 6 and 7 are closed. In the case of each ram 1 the left hand end of the cylinder 10 is connected by a duct 21 to a fluid pressure line 22 which is common to all of the cylinders 10 of the system. The line 22 is connected to a manually operable change-over valve 23, which is connected to the main pressure line 8, by a duct 24, and to the main return line 9 by a duct 25. The right hand side of each cylinder 10 is connected by a duct 26A with an associated pilot operated changeover valve 26 connected by a duct 27 to the duct 6, by a duct 28 to the duct 5 and by a duct 29 to the duct 21. The duct 4 is connected by a duct 30 through a pilot operated stop valve 31 to the duct 7. The valve 31 is connected by a duct 32 to the duct 21.

In the neutral state of the valves, as shown in Figure 2 displacement of fluid from the ram 1 is prevented by the valves 3, 26, and 31. Operation of the valve 3 may cause the ram 1 to pull or push as required. In the neutral state fluid can flow from the main pressure line 8, through the duct 27, the valve 26, and the duct 26A to the right hand side of the piston 11 thereby displacing the piston to the left, fluid displaced by the piston flowing through the duct 21, the fluid line 22, the valve 23 and the duct 25 to the return line 9. It is arranged that the pressure generated within the duct 21 is insufficient to operate the valves 26 and 31.

If the valve 23 is operated to connect the main pressure line 8 to the line 22, pressure fluid is applied along the ducts 21 and 29 to the valve 26, and along the ducts 21 and 32 to the valve 31. The valves 26 and 31 are operated, thereby connecting the pull side of the ram 1 to the main return 9 through ducts 4, 30 and 7, the right hand side of the cylinder 10 to the duct 28, and thus to the push side of the ram 1. The piston 11 is thus displaced thereby forcing fluid through the

ducts 26A, 28 and 5 into the ram 1. Since the duct 4 is closed fluid from the pull side of the ram is displaced through the ducts 30, the valve 31, and duct 7 to the return line 9. Each ram 1 is thus caused to extend from its original position by an amount depending on the area of its cylinder and the volume of fluid displaced from the cylinder 10.

When all the pistons 11 reach the right-hand ends of the strokes all fluid flow ceases and valve 23 is then restored to its neutral position, thereby venting the ducts 21, 32, 29, through the line 22, and duct 25 to the main return 9. The valves 31 and 26 will then automatically return to their neutral positions and fluid will once again be able to enter the right hand end of the cylinder 10 to force the piston 11 to the position shown in Figure 2 so that the cycle can be repeated.

The differential pushing feature described in relation to Figure 1 and the locked neutral valve settings of Figure 2 may be interchanged.

Figure 3 illustrates a modification of the circuit of Figure 2 which enables pilot operation. In Figure 3, except for valve 3, the components, fluid lines and ducts numbered from 1 to 11 are similar to those used in the circuit of Figure 2. The valves 3 of Figure 3 whilst having the same control characteristics of the valves 3 of Figure 2, are spring centred and are both manually and pilot operable.

A pilot operated change-over valve 33 is interposed in the duct 6, effectively dividing it into sections 6*a* and 6*b*. The right hand side of the cylinder 10 is connected through a duct 35 to the valve 33, the latter being connected by a duct 37 to the duct 7.

A main pilot pressure line 38 extends along the face and connects at one end with a valve 39 connected by ducts 40 and 41 to the fluid lines 8 and 9 respectively. Pilot pressure for operating the valves 3, and 33, is obtained from the pilot line 38 by ducts 42 and 43.

The neutral state of the circuit is as shown in the Figure. In this neutral state displacement of fluid from the ram 1 is prevented by closure of the ducts 4 and 5 by the valve 3. As fluid pressure can pass from the pressure line 8 through the duct part 6*b*, the valve 33 and the duct part 6*a* to the valve 3 and as the valve 3 is connected through the duct 7 to the return line 9 manual operation of the valve may cause the ram 1 either to pull or to push.

In the neutral state pressure fluid from the line 8 passes through the duct part 6*b*, the valve 33, the duct part 6*a* and the duct 34 to the left hand end of the cylinder 10 thereby displacing the piston 11 to the opposite end of the cylinder. Fluid displaced from the cylinder 10 returns to the return line 9 by way of the duct 35, the valve 33, the duct 37 and the duct 7. The piston 11 is thus automatically moved to and held at the right hand end of the cylinder 10. Thus all of the pistons 11 are moved to the position shown.

On operation of the valve 39 to connect the main fluid line 8 to the pilot line 38 pilot pressure is simultaneously applied to all of the valves 3 and 33. Each valve 3 then connects the duct part 6*a* to the duct 5 and the duct 4 to the duct 7, and each valve 33 connects the duct part 6*b* to the duct 35 and blocks the duct part 6*a* and the duct 37. Fluid from the main pressure line 8 therefore passes through the duct 6*b* the valve 33 and the duct 35 into the right hand end of the cylinder 10, thereby displacing the piston 11 to the left. Fluid from the opposite side of the piston is displaced through the duct 34, the duct part 6*a*, the valve 3 and the duct 5 to the push side of the ram. Fluid from the pull side of the ram 1 travels through the duct 4, the valve 3 and the duct 7 to the return line 9.

When the piston 11 reaches the left hand end of its stroke all flow of fluid ceases and the valve 39 is then returned back to its original position thereby venting the line 38 and the ducts 42 and 43 so that the valves 3 and 33 are restored to their neutral positions. Fluid pressure from the main line 8 re-enters the cylinder 10 through the ducts 6 and 34 and forces the piston to the right hand end of its travel so that it is ready for another operation.

The above described control circuit is suitable for use with installations of remotely operated roof supports in which the ram control valve 3 would be pilot operated both to effect the push and pull operation of the ram 1.

In Figure 4 a plurality of hydraulic rams 50A, 50B (only two shown) are attached to a mine face conveyor 51, arranged along a mine face 49 the rams being spaced along the mine face 49. Each ram is connected to an associated anchorage—illustrated in the Figure as roof supports 53A, 53B. The operation of each ram is controlled by an associated control circuit. The control circuits are all the same and for convenience the components of each such circuit will be uniquely identified by sufficies A.B. etc.

Each ram 50 can be controlled by a manually operable control valve 54 connected to the push side of the ram by a duct 55 and to the pull side of the ram by a duct 56. The valve 54 is also connected by a duct 57 to a main pressure line 58 and by a duct 59 to a main return line 60. The lines 58 and 60 extend across the width of the mine face 49 and are common to all of the ram control circuits.

A fluid store in the form of a fluid dispensing cylinder 61A containing a floating piston 62A is associated with each ram 50A.

In each case the displacement of the piston is controlled by double pilot operated change-over valves 63A and 64A having the characteristics shown in the drawings. The left hand end of the cylinder is connected through a duct 65A to the valve 63A, and by a duct 66A to the valve 64A. The right hand end of the cylinder is connected through a duct 67A to the valve 63A and by a duct 68A to the valve 64A. The valve 63A is connected through a non-return valve 69A to the duct 55A. The left and right hand side pilot connections of the valves 63A and 64A are connected by ducts 70A and 71A respectively to a valve 72A, which is in turn connected by ducts 73A and 74A to the pressure line 58 and the return line 60 respectively.

The neutral state of the circuits is as shown in Figure 4. The operation of the circuit will now be considered in relation to the ram 50A. In the neutral position shown fluid pressure is transmitted from line 58, through duct 73A, valve 72A, duct 71A to the valves 63A and 64A holding these in the positions shown. In addition fluid pressure is transmitted from line 58, duct 77A, valve 64A and duct 68A to the right hand end of the cylinder 61A. The right hand end of the cylinder 61A is connected by the duct 67A, the valve 63A, the duct 78A and valve 69A to the duct 55A. The pull side of the ram 50A is connected through the duct 56A, the valve 54A, and the duct 57A to the fluid supply line 58. The push side of the ram 50A is isolated by the valves 54A and 69A.

If the valve 72A is now operated the left hand side pilot connections are pressurised through the duct 70A the valve 72A and the duct 73A, whilst the right hand side pilot connections are vented through the duct 71A, the valve 72A and the duct 74A.

The valves 63A and 64A can now change-over. After this change over pressure fluid can flow from the line 58 through the duct 77A the valve 64A and the duct 66A, into the left hand end of the cylinder 61A. At the same time the right hand end of the cylinder is connected through the duct 67A, the valve 63A, the duct 78A and the valve 69A and the duct 55A to the push side of the ram 50A so that the ram 50A is advanced. This advance is continued until the piston 62A has completed its travel to the right hand end of the cylinder 61A. During advance of the ram 50A fluid is forced from the pull side through the duct 56A, the valve 54A and duct 57A to the fluid supply line 58. At the end of this stroke of the piston 62A, the left hand side of the piston 61A will be filled with pressure fluid.

Each time the valve 72A is changed over the valves 64A and 63A are simultaneously reversed and the ram 50A is advanced by an increment which depends upon the ratio of the area of the cylinder of ram 50A to the area of the dispensing cylinder 61A and upon the stroke of the piston 62A. This latter mentioned piston stroke may be varied by means (not shown) for limiting the travel thereof.

When the available stroke of the ram 50A has been exhausted by the successive short extensions the valve 54A may be operated to advance the ram cylinder. On operation of the valve 54A in this sense the pulling side of the ram 50A is connected to the main pressure line 58 through the ducts 56A, the valve 54A and the duct 57A whilst the pushing side of the ram is connected to the main return line 60 through the duct 55A, the valve 54A and the duct 59A.

Operation of the valve 54A in the opposite sense causes the ram 50A to push independently for the purposes of adjustment and/or maintenance.

In the above described embodiment the pilot connections of the valves 63A and 64A are connected to the valve 72A, that is the valve forming part of the control circuit of the ram 50A. If, however, it is desired that the conveyor should snake across immediately after a coal cutting machine has passed, the pilot connections of valves 63, 64 are connected with valves 72 other than that of their own circuit. Thus, for example, the duct 71A, instead of being connected to the valve 72A as shown, may be connected to the corresponding part of the valve 72B. The duct 71B may be connected to the valve 72C in similar manner, and so on. The duct 70A may be connected to the corresponding part of a valve 72 to the left of the ram 50A (such valve not being associated with a ram, since this is the end of the face), the duct 70B to the valve 72A, the duct 70C to the valve 72B and so on.

Thus operation of a valve 72 by or in conjunction with a coal-getting machine moving along the conveyor 51 from left to right then pressurises the duct 71 of the control means associated with the ram 50 to the left of the valve 72 and vents the duct 70 of the control means associated with the ram 50 to the right of the valve 72, so that the valves 63 and 64 associated with that ram can be operated by subsequent pressurisation of the associated duct 71 by operation of the next valve 72. All the valves 72 being operated in sequence, in like sense, each ram 50 is thereby caused to extend as the valve 72 to its right is operated.

If the coal-getting machine is reversed so that the valves 72 are operated in sequence in the opposite sense, each valve 72 pressurises the duct 70 associated with the ram 50 to its right while venting the duct 71 associated with the ram 50 to its left. Each ram 50 is thereby caused to extend as the valve 72 to its left is operated. With the above modification the advance of the conveyor therefore progresses across the face behind the coal cutting

machine in both directions of travel of the latter.

The lag between machine passage and conveyor snaking can be adjusted, to suit any special conditions by coupling the valves 72 to rams more remote than the adjacent rams.

Adjacent sets of two or more of the rams 50 may be caused to extend together by connecting together all their associated ducts 71 in parallel to a valve 72 at the right-hand end of the set and all the ducts 70 in parallel to a valve 72 at the left-hand end of the set.

Referring now to Figures 5 and 6 of the drawing, a number of double-acting hydraulic rams 1 (of which only one is shown), are attached at spaced intervals along a mine face 2A. Each ram 1 is controlled by a changeover valve 3 which is connected to the pull side of the ram 1 by a duct 4 and to the push side of the ram 1 by a duct 5. The valve 3 is also connected by means of ducts 6 and 7 to the main pressure and return lines 8 and 9 respectively, which pass along the mine face 2A.

Associated with each ram 1 is a hydraulic accumulator 80 whose fluid storage part of the accumulator 80 is connected by a duct 81 into a duct 82 connected at one end into the duct 5 and at the other end into a "priming pressure" supply line 83 which passes along the mine face. A check valve 84 is interposed in the line 81 between its connections to the line 83 and the duct 81 and a pilot-operated check valve 85 and a check valve 86 are interposed in the duct 82 between its connections to the duct 81 and the duct 5. The pilot-operating means of the valve 85 is connected by a duct 87 into a main pilot line 88 which passes along the mine face. The lines 83 and 88 are connected at one end of the mine face to a valve 89. The valve 89 receives a pressure supply through a duct 90, in which is interposed an adjustable pressure regulating valve 91. The valve 89 is also connected, by means of a duct 92, into the main return line 9. Known means, not shown, are used to isolate the pressure supply in the duct 90 from fluctuations of pressure in the line 8.

In the neutral state shown in Figure 5, pressure from the line 8 is applied by means of the duct 6, the valve 3 and the duct 4 to the pulling side of the ram 1. The ram 1 is, however, restrained against retraction by closure of the duct 5 by the valve 3 and the duct 82 by the valve 86. It is arranged that the pressure in the line 8 is sufficient to overcome any external pulling force on the ram 1 which may be generated by, for example, passage of a coal-winning machine along the conveyor 2. The ram 1 is thus effectively locked at any extension to which it may be set. Operation of the valve 3 to connect the duct 5 to the duct 7 while maintaining the connection between the duct 4 and the duct 6 will cause the ram to pull. Operation of the valve 3 in the opposite sense to connect together the ducts 4 and 7, 5 and 6 respectively, will cause the ram 1 to push. By this means, the extension of the ram 1 may be adjusted as desired.

Also in the neutral state shown in the drawing, fluid passes along the priming pressure line 83 and through the duct 82, the valve 84 and the duct 81 into the accumulator 80. Flow continues until all the accumulators 80, the ducts 81, the ducts 82 as far as the valve 85 and the line 83 along the mine face are charged to a pressure determined by the setting of the pressure regulating valve 91. In this state there will be stored in each accumulator 80 a quantity of fluid determined by the known characteristics of the accumulator 80 and the priming pressure maintained by the valve 91.

If now the valve 89 is operated to connect the line 83 to the duct 92 and the line 88 to the duct 90, the pressure in the line 83 and in the duct 82 as far as the check valve 84 will be relieved. The valve 84 will, however, prevent discharge of fluid from the accumulator 80.

At the same time, pressure will be applied through the line 88 and the duct 87 to the pilot-operating means of the valve 85, which will open and permit discharge of fluid from the accumulator 80, into the duct 5. The duct 5 being closed at one end by the valve 3, the only path for the discharged fluid is into the push side of the ram 1. Since the pressure required in the push side of the ram 1 to overcome the pressure maintained in the pull side and, in addition, any external load, is less than the pressure at which the accumulator is fully discharged, the ram 1 will be extended by an amount depending on the cross-sectional area of its cylinder and the volume of fluid discharged from the accumulator 80.

When flow ceases, the valve 89 may be restored to its neutral position, thereby recharging the accumulator 80 with a further volume of fluid, ready for another operation. By suitable choice of the characteristics of each accumulator 80 in relation to its associated ram 1, it can be arranged that operation of the valve 89 causes all the rams 1 along the mine face to extend together in equal steps or increments until they are fully extended, when they may be restored to the fully closed position by operation of the valve 3. The actual amount of each increment may be varied between pre-selected limits by adjustment of the valve 91.

The method of extending the ram 1, whereby the pressure on the pushing side has to overcome a pressure maintained on the pulling side in addition to the external load, is known but in some cases it may be preferred to vent the pulling side of the ram 1 to return during the time that pushing is taking place. This may be achieved by a 'locked neutral' for example by using an arrangement using the different form of the valve 3 and the duct 30

and the valve 31 of Figure 2 with the pilot-operating means of the valve 31 connected to the duct 87. By this means, the ram 1 is restrained in the neutral state against either extension or retraction by closure of all ducts connected to it. Operation of the valve 89, to pressurise the pilot line 88 will then simultaneously operate the valve 85, allowing the accumulator 80 to discharge into the pushing side of the ram 1, and the additional pilot-operated valve, allowing fluid displaced from the pulling side of the ram 1 to pass through the duct 4, across to the duct 7 and so into the main return line 9.

In the above embodiment, the accumulator 80 may be of any known type and the volume of fluid stored in it is determined entirely by its characteristics in relation to the priming pressure determined by the setting of the valve 91. A further embodiment may be used only with any accumulator in which a mechanical means can be used to limit the quantity of fluid stored independently of any variation in the priming pressure above a certain minimum. This may be better understood by reference to Figure 6 which shows only that part of the circuit associated with an accumulator 80. In this embodiment, the accumulator 80 comprises a cylinder 80*a* containing a piston 80*b*. Priming fluid enters by means of the duct 81, as before, and displaces the piston 80*b* against the resistance of a mechanical spring 80*c*. The displacement of the piston 80*b* and therefore the volume of fluid required to effect it may be limited by a stop 80*d* which may be adjusted in a manner not shown. Provided that the pressure supply to the duct 81 is never allowed to fall below that required to overcome the resistance of the spring 80*c* to the maximum required displacement of the piston 80*b*, the volume of fluid stored in the accumulator will be determined entirely by the adjustment of the stop 80*d*. When such an accumulator is used in the circuit of Figure 5, the valve 91 may be dispensed with but it is necessary to ensure that the pressure supply to the duct 90 does not fall below the minimum pressure just described. The operation of the system will then be exactly as before, except that the amount of extension of each ram 1 will be determined by individual adjustment of the stop 80*d* in the associated accumulator 80.

In the arrangement of Figures 5 and 6 the control of the storage volume of the accumulator may be affected remotely.

WHAT WE CLAIM IS:—

1. A system for controlling the advance of a snakable conveyor advanceable by a plurality of double-acting hydraulic rams connected at spaced intervals to the conveyor, comprising, for each ram, control means which is adapted on actuation thereof to cause its associated ram to advance the conveyor by a predetermined increment of distance less than the complete stroke of the ram, and which is adapted to restrain the associated ram against extension and retraction of the ram under the effect of external forces.

2. A system as claimed in claim 1, wherein said control means includes a fluid storage means in the form of a variable-volume chamber which stores a quantity of hydraulic fluid which is sufficient, on subsequent discharge into said ram to act on the conveyor advancing side thereof, to advance the ram by one of said increments.

3. A system as claimed in claim 2, wherein all of the fluid storage means are simultaneously recharged or primed with fluid from a common fluid supply.

4. A system as claimed in claim 2 or 3, wherein the storage capacity of each storage means is selectively variable.

5. A system as claimed in any of claims 2 to 4, wherein each fluid storage means includes a piston movable in a cylinder connected to receive a charge of fluid from a fluid supply and on said actuation, to dispense the fluid charge to its associated ram and wherein the swept volume of the cylinder defines the volume of fluid dispensed.

6. A system as claimed in any of claims 2 to 4, wherein the fluid storage means comprises a hydraulic accumulator connected to receive a charge of fluid from a pressurised fluid supply and adapted to dispense, on said actuation, sufficient fluid at sufficient pressure to cause the associated ram to advance by said increment.

7. A system as claimed in claim 6, wherein the amount of fluid stored in the accumulator and consequently the amount of said ram increment is selectively predetermined by the adjustment of the pressure of said fluid supply.

8. A system as claimed in any of claims 2 to 7, wherein a second control means is provided for each ram, the second control means being operable independently of the first control means.

9. Ram apparatus comprising a double-acting hydraulic ram, a control valve operable to a first position to pass fluid to and simultaneously pass fluid from the ram to cause non-incremental operation of the ram and operable to a second position to prevent exhaust of fluid at least from one side of the ram piston, a variable-volume chamber, and a fluid-pressure-responsive valve operable to pass fluid expelled from the variable-volume chamber to said one side of the ram piston so that the ram piston moves through one increment while the control valve is in said second position.

10. A system for controlling the advance of a snakable mine face conveyor, substantially as hereinbefore described with reference

to and illustrated in Figures 1, 2, 3, 4 or 5, or Figures 5 and 6 of the accompanying drawings.

11. Ram apparatus for use in a system as claimed in claim 1, being any one double-acting hydraulic ram and the control apparatus associated particularly therewith substantially as hereinbefore described with reference to and illustrated in Figures 1, 2, 3, 4 or 5, or Figures 5 and 6 of the accompanying drawings.

For the Applicants,
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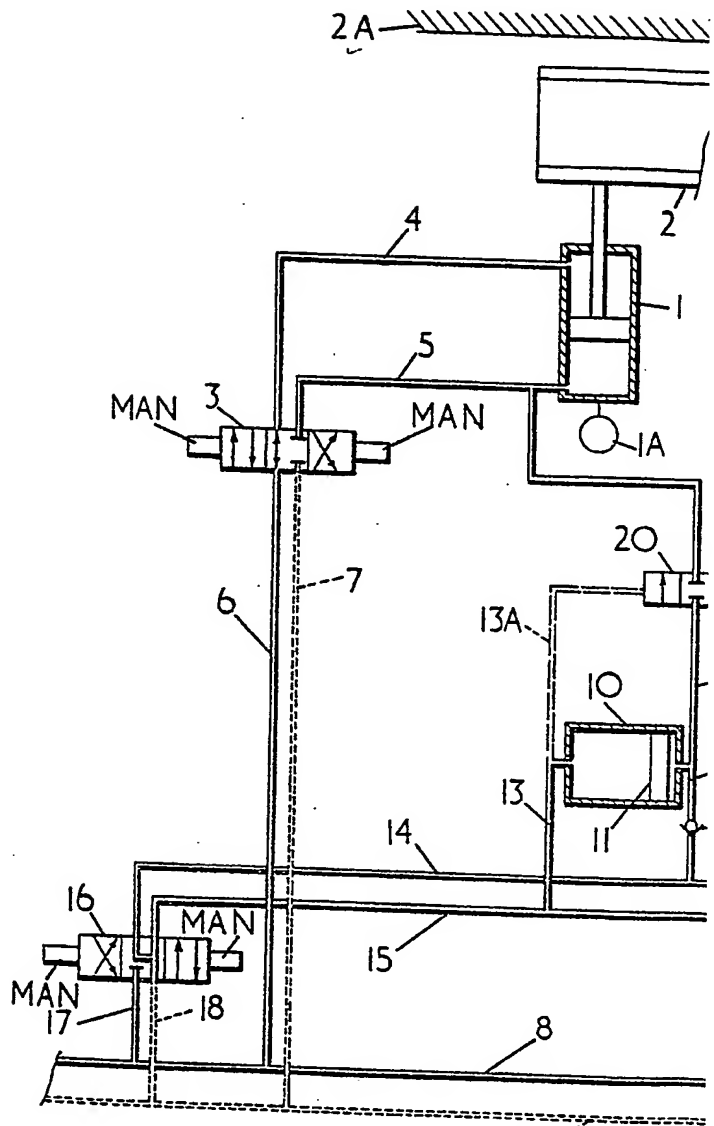
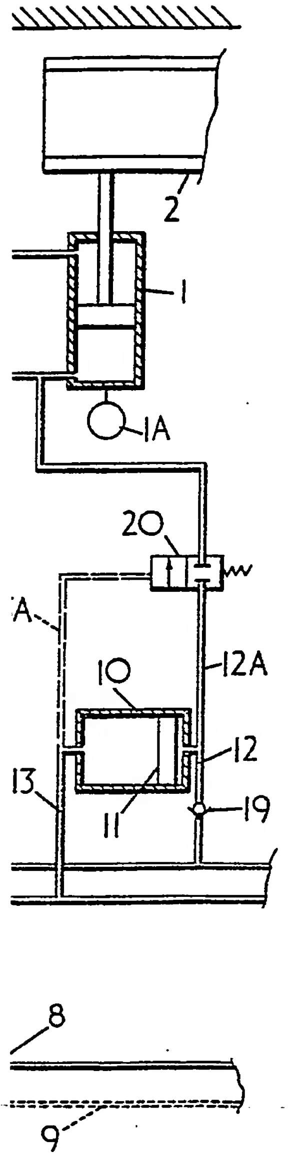


FIG.1.

1160451 AMENDED SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1



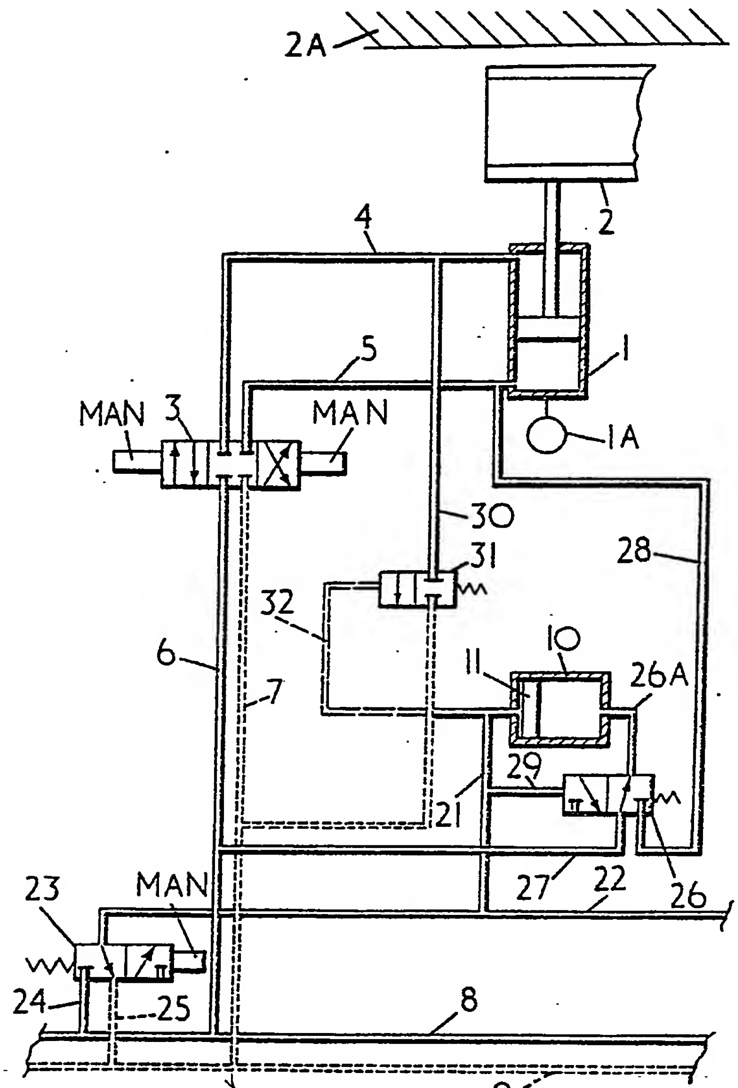


FIG.2.

1160451 3 SHEETS

AMENDED SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale

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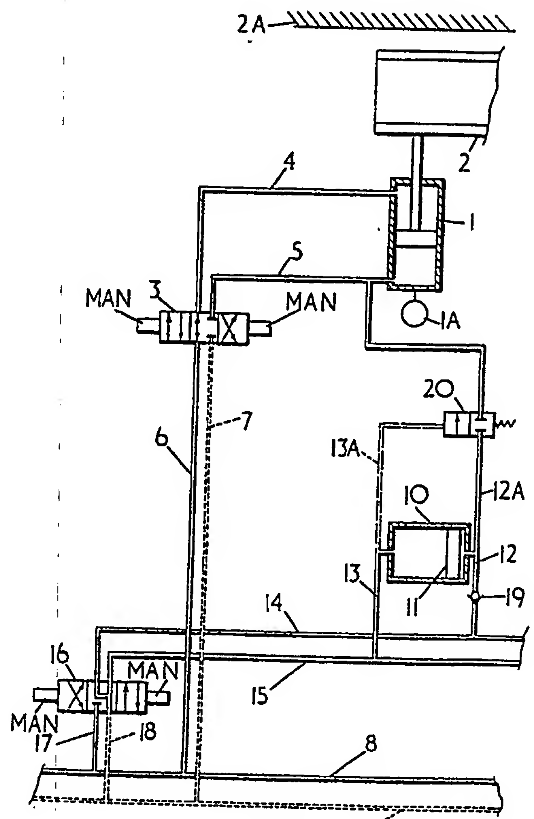


FIG.1.

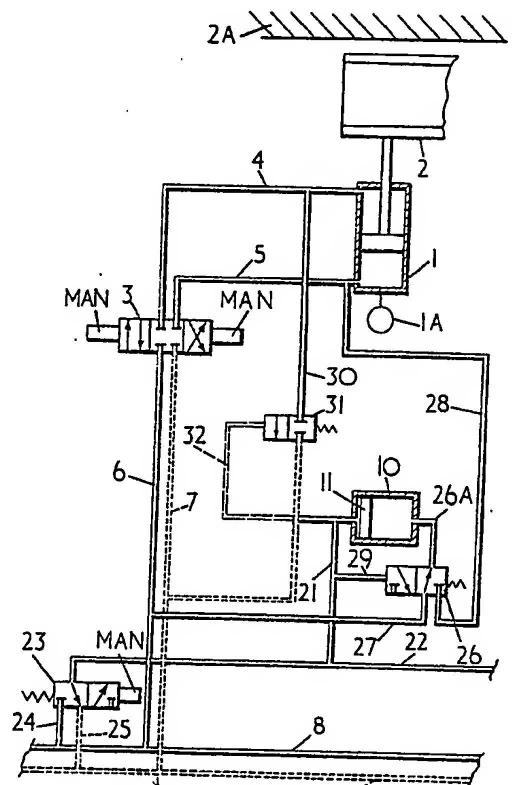
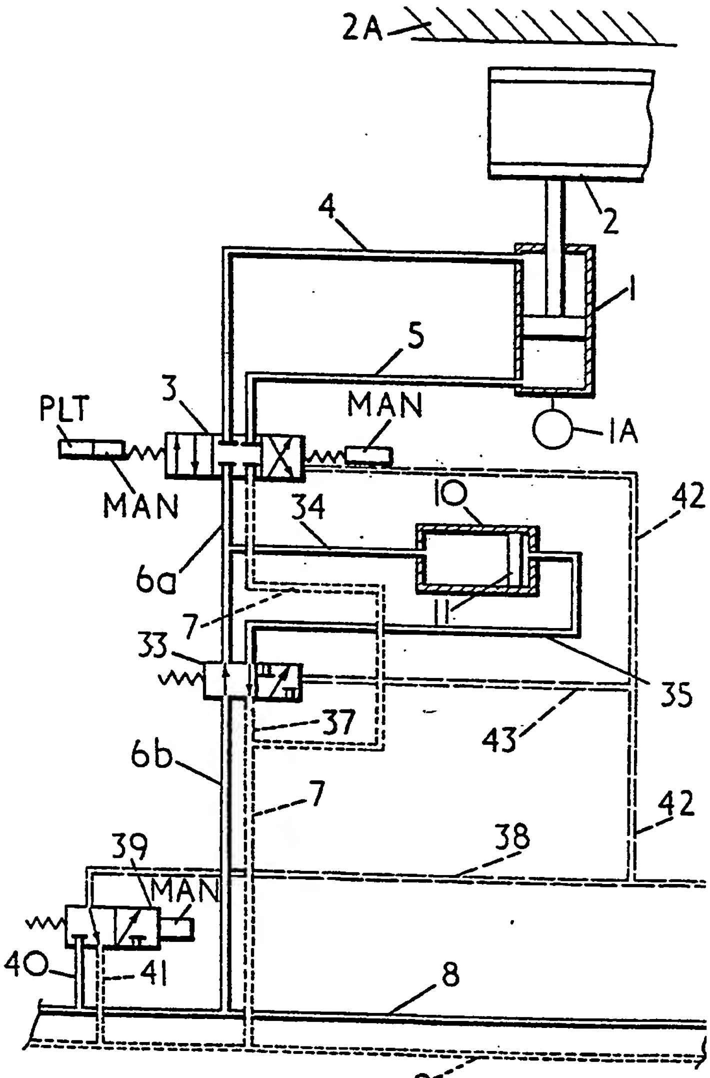


FIG.2.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3
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MAN
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10
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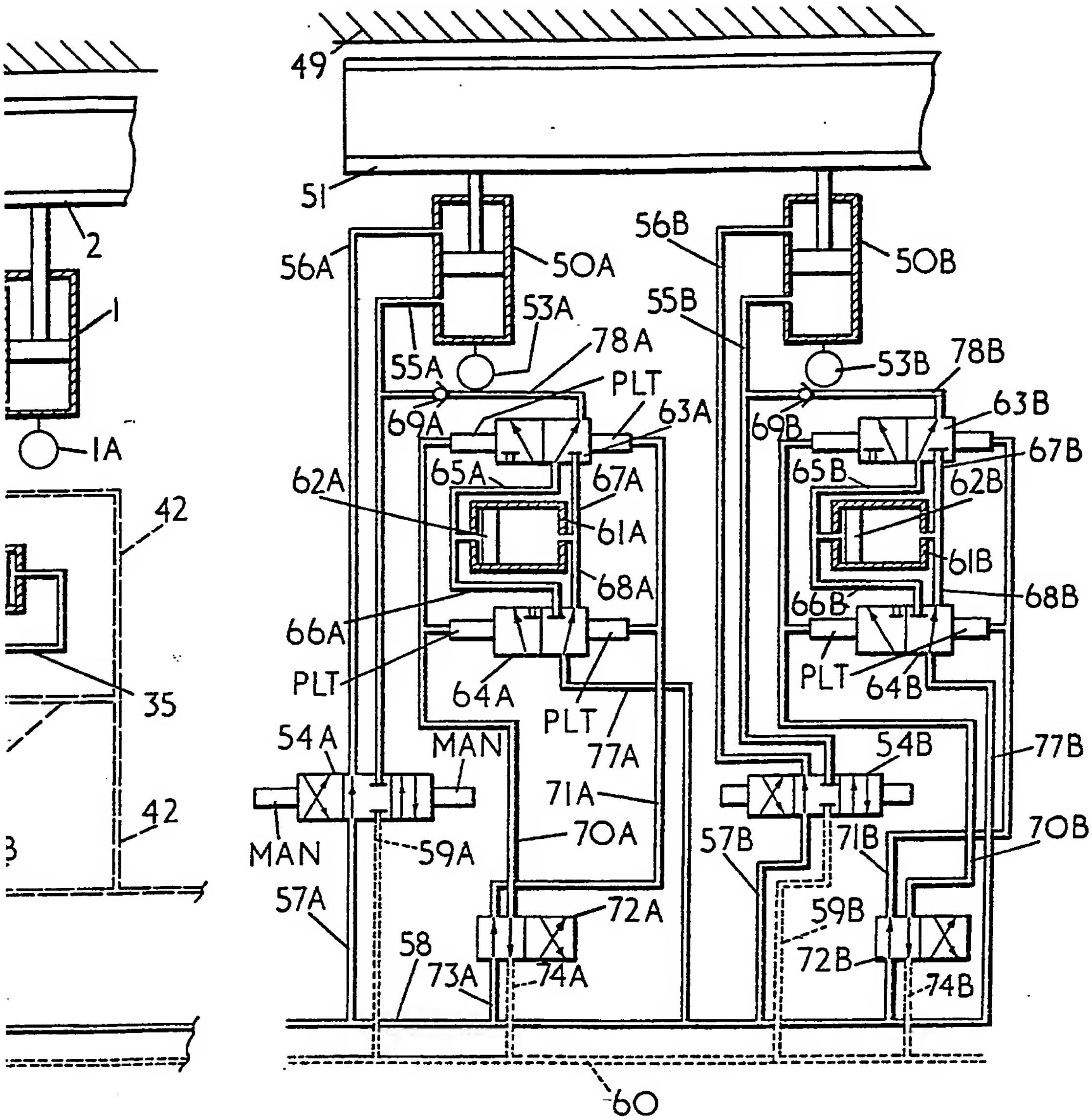
35
43
37
6b
7
42
38
39
MAN
40
41
8
9

FIG.3.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55B
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PLT
63A
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68B
66A
66B
PLT
64A
64B
PLT
54A
MAN
PLT
77A
54B
77B
71A
MAN
59A
70A
57B
71B
70B
57A
72A
59B
58
72B
73A
74A
74B
60

FIG.4.

1160451 AMENDED SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

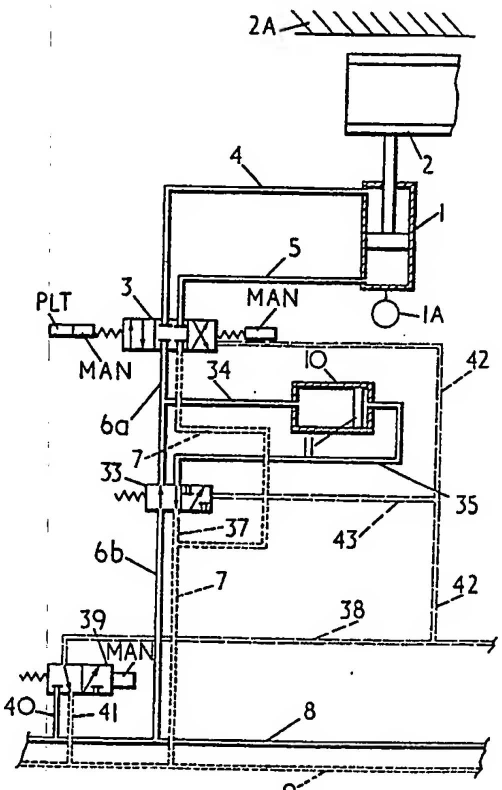


FIG.3.

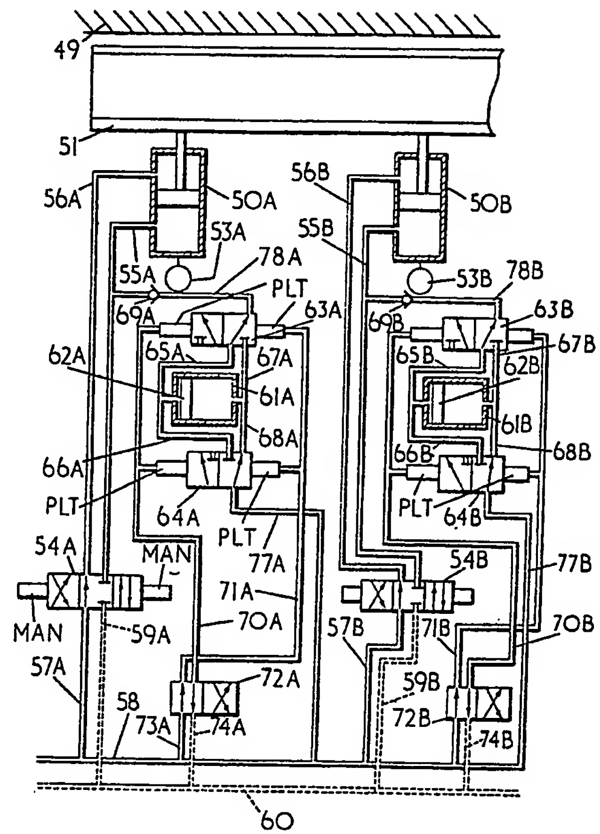
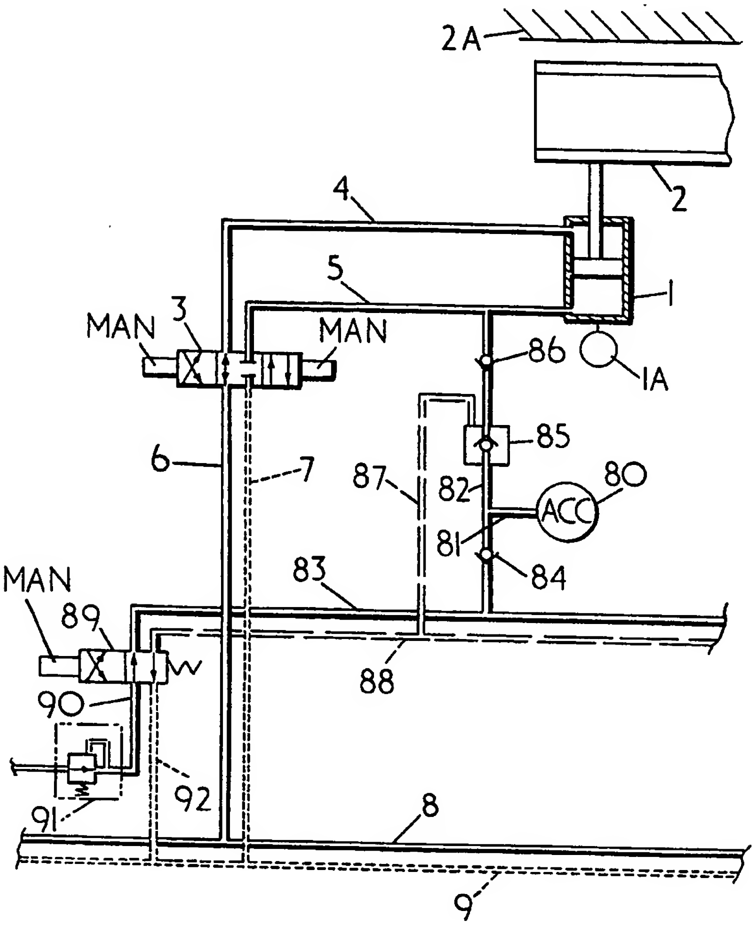


FIG.4.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90
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92
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9

FIG.5.

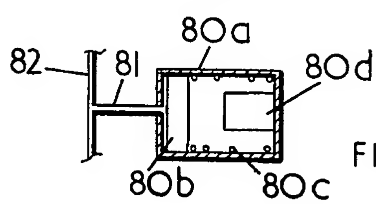
80a
82
81
80d
80b
80c

FIG.6.